Search for WH$\rightarrow$WWW$\rightarrow l^{\pm}\nu\, l'^{\pm}\nu' + X$ at DØ detector

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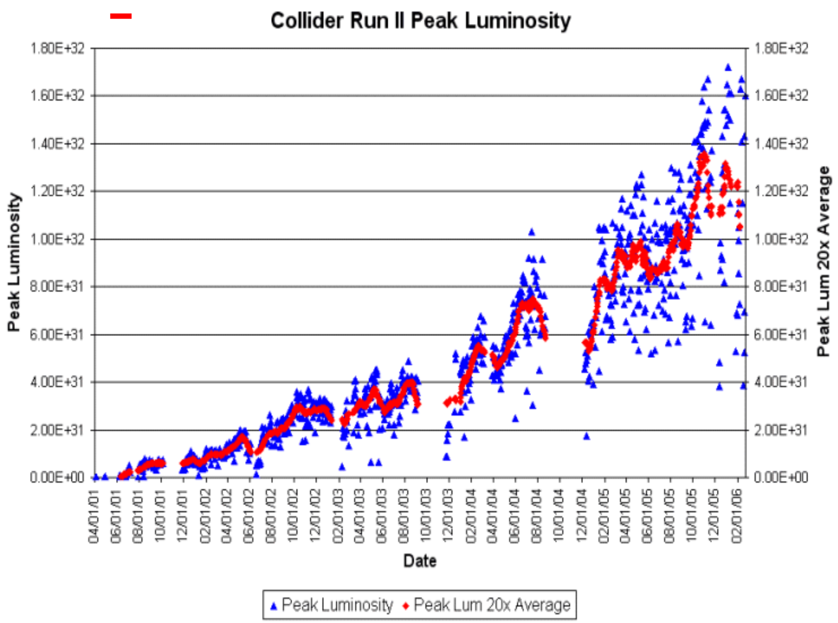
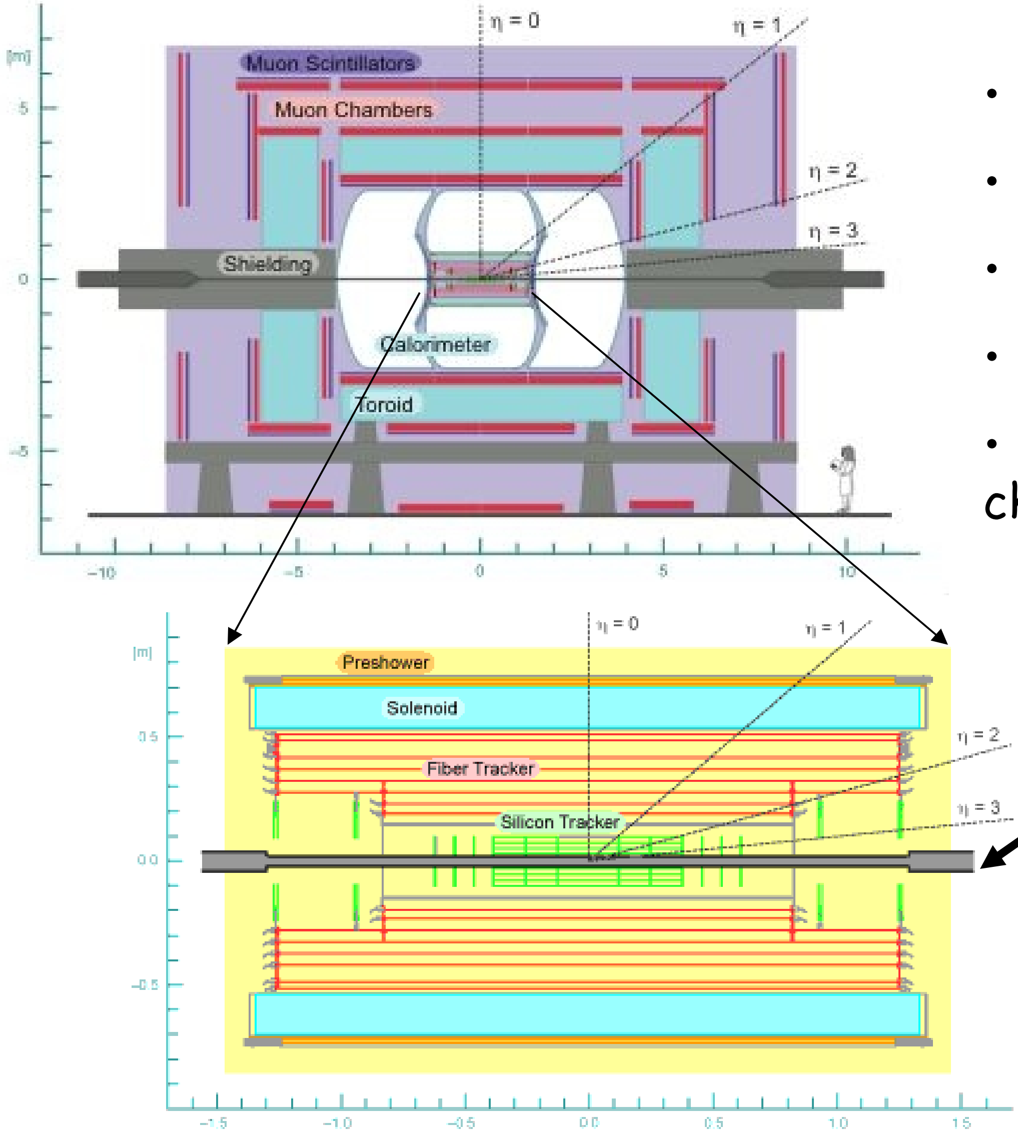
on behalf of DØ collaboration
DPF 2006

Tevatron Collider



- $p\bar{p}$ Collider with $\sqrt{s}$ =1.96TeV
- Two experiments: **CDF** and **DØ**
- Run I $\int L dt \sim 125\ pb^{-1}$
- Run II currently $> 1\ fb^{-1}$
- Run II expected: $4 - 8\ fb^{-1}$

DØ Detector at Tevatron

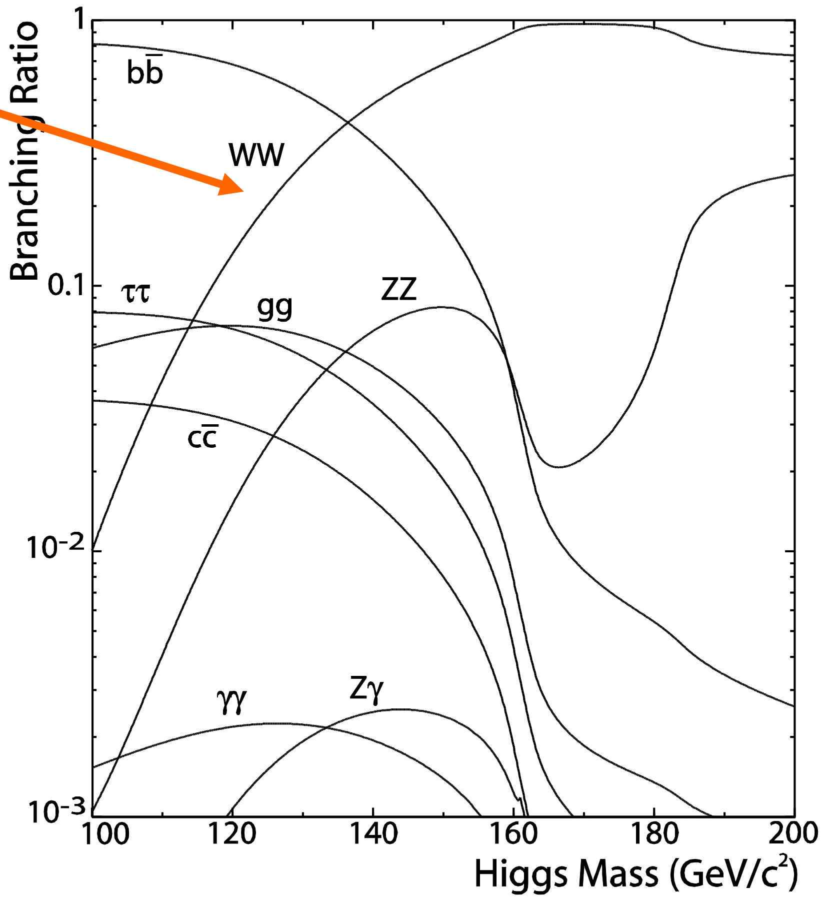


- Silicon microstrip tracker (SMT)
- Scintilating Fiber tracker
- 2 Tesla solenoid
- Liquid argon Calorimeter
- 3 layers of muon scintilator and wire chambers

DØ Run II tracking system

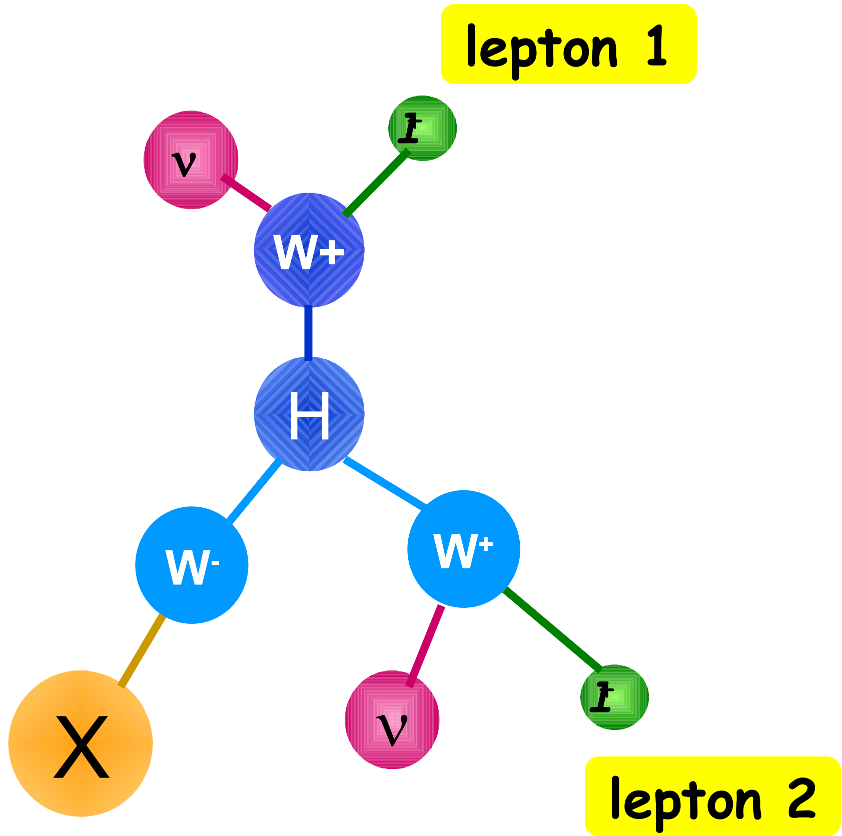
Why this channel is interesting ?

- H→W W* decay mode dominates SM Higgs masses above 135 GeV
- In fermiophobic Higgs models Br(H→ W W*) may be close to 100% for Higgs masses as low as 100 Gev.
- H →bb mode suffer from Wbb background
- Have smaller physical backgrounds than direct Higgs production $p\bar{p}$ →H →W W* which suffer from Z/γ*, WW and ttbar production.



WH→ WWW → $l^{\pm}\nu\, l'^{\pm}\nu'$ + X signature

- 2 high-P_T like-sign leptons (e,μ)
- Missing transverse energy (ME_T) from neutrinos



Physical backgrounds are:

- WZ → $l^{\pm}\nu\, l'^{\pm}\nu'$
- ZZ → $l\,l\;\; l'\,l'$
- Triple vector boson: VVV (V=W,Z)
- ttbar + V

These are negligible backgrounds

Event selection

- Di-lepton Trigger (ee,eμ, $\mu\mu$)
- 2 like sign leptons P_T> 15 GeV

Electron:

- Central calorimeter (CC) electron ($|\eta_{det}|<1.5$)
- Standard EM cuts: iso<0.15, emf>0.9
- Calorimeter shower shape consistent with electron (Lhood>0.85)
- Spatial and momentum match between track and EM cluster

Muon:

- "loose" quality with central track match
- passes cosmic veto
- Doesn't share its track with an electron candidate
- Jet isolation: $\Delta R(\mu,j)>0.5$
- Track and calorimeter isolation

Instrumental backgrounds

1. **"Charge flips"** (charge mismeasurement of one of the leptons). Same-flavor channels (ee, $\mu\mu$) are dominated by Z/γ^*.

3. **Like-sign lepton pairs from multijet and W+jets production**

   In the case of muons, these can be:
   - real muon from heavy flavor jets
   - punch-through hadrons
   - muons from π/K decays

   In the case of electrons it is:
   - heavy flavor decay to electron
   - Hadrons misidentified as electrons

Additional track quality cuts

In order to reduce instrumental background tighter track cuts applied

Tracks required:

- Have at least 2 SMT (Silicon Microstrip Tracker) and 5 CFT (Central Fiber Tracker) hits
- A small distance of closest approach (DCA) to the beam axis $|dca| < 0.1$cm
- A small distance between Z-position of the lepton track at DCA and event primary vertex (PV) $\Delta Z(l,PV) < 1$cm.
- A small DCA significance $|dca/\sigma(dca)| < 3$

Background estimation

- “Physical” (ZZ,WZ) normailized on theoretical cross-section

- QCD and “charge flips” fractions are estimated by fitting lepton invariant mass (M_{ll}) in data using:

  - QCD shape derived from data sample where e or μ or both fail isolation/likelihood cuts.

  - “Charge flips” probability curve (as a function of lepton P_T) taken from MC simulation of W and Z decays.

  - To avoid bias from potential signal fit is performed on the sample of events which failed TLD cut

Topological likelihood discriminant

In order to improve S/B ratio final selections based on topological likelihood discriminant (**TLD**):

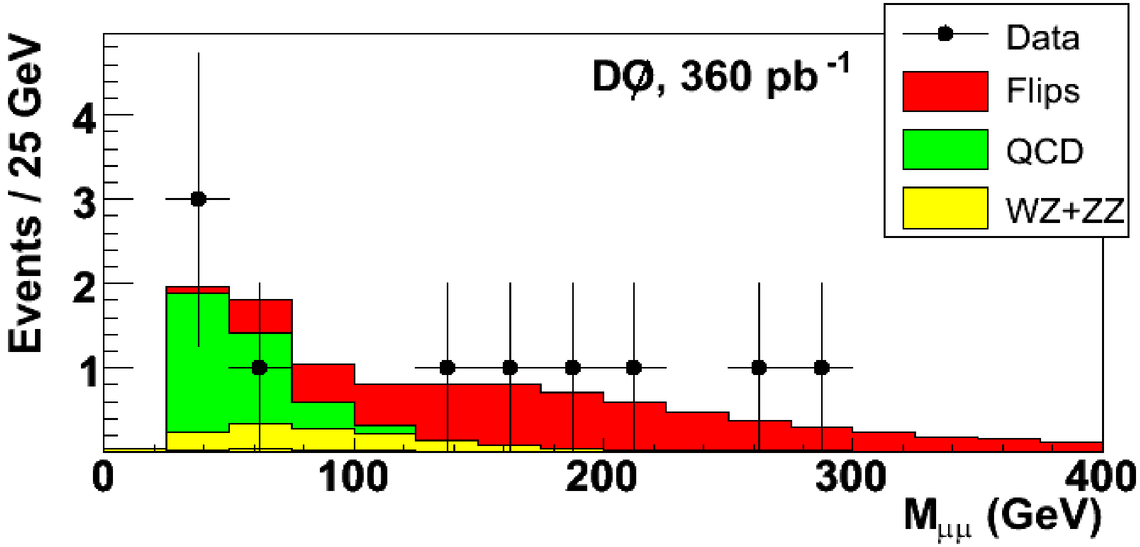
$$lhs(v_1, \ldots, v_n) = \frac{\prod_i s_i(v_i)}{\prod_i s_i(v_i) + \prod_i b_i(v_i)}$$

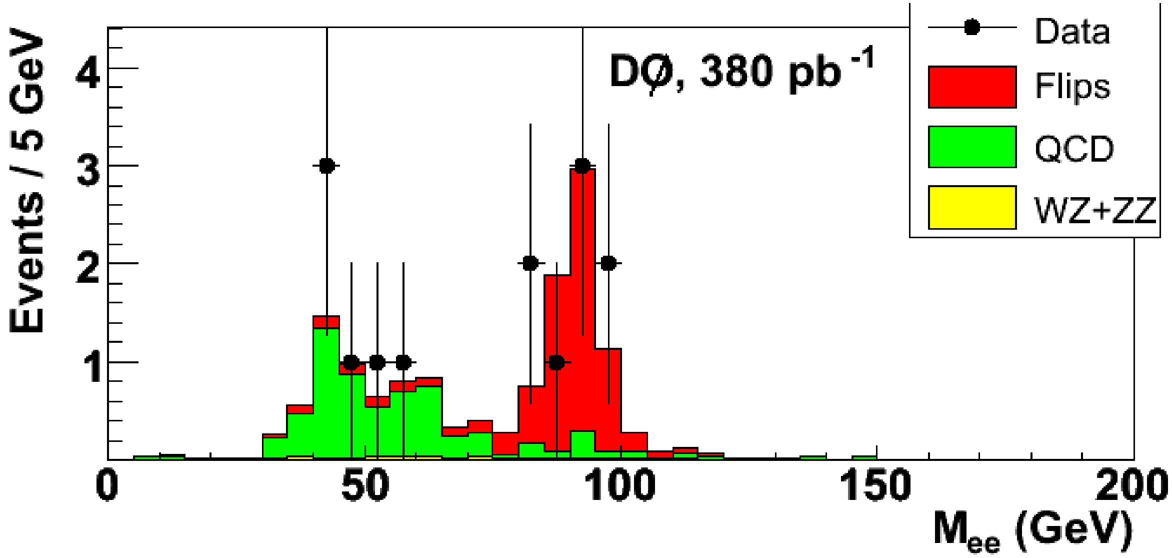
Where $s_i(v_i)$ and $b_i(v_i)$ are signal and background probability density of variable v_i

Topological variables are following:

- Opening angle $\Delta\varphi_{\mu\mu}$ ($\mu\mu$ channel)
- ME_T (ee,eμ channels)
- Hadronic ME_T(ME_T not corrected for leptons) (all channels)

Dilepton Mass fit for ee and μμ



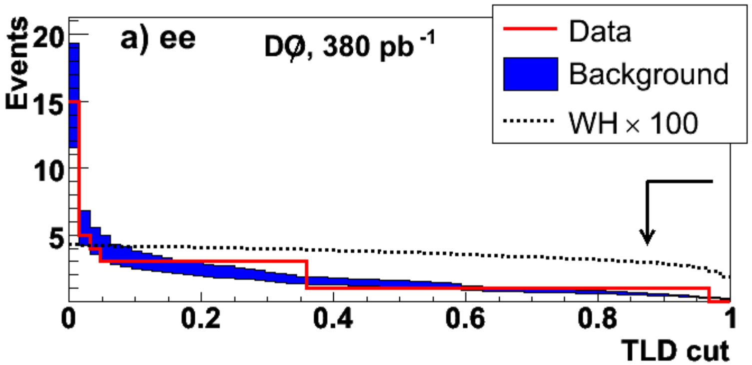


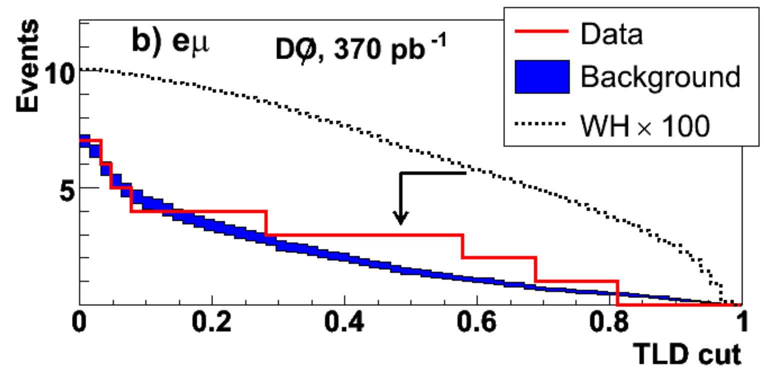
TLD cut selection

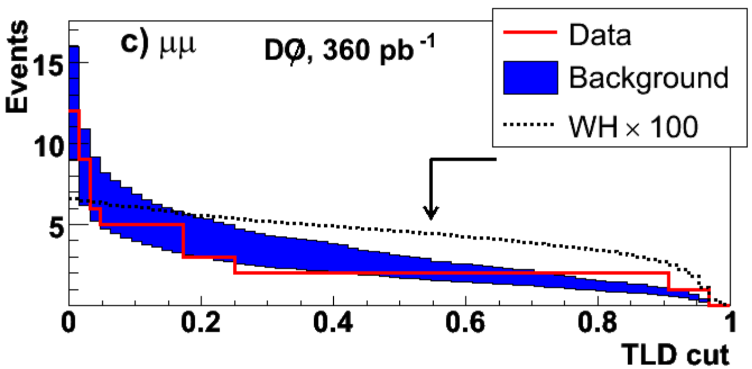
TLD cut is optimized for best expected limit for each higgs mass and channel (ee,μμ,eμ) individually:

	ee	eμ	μμ
M_H=115	0.8	0.39	0.34
M_H=135	0.81	0.48	0.50
M_H=155	0.88	0.48	0.55
M_H=175	0.80	0.50	0.69

Data and predicted SM background as a function of TLD cut







TLD cut shown is optimized for M_H=155 GeV

After the TLD cut we have:

- 1 ee event
- 3 eμ events
- 2 μμ events

Results: expected and observed number of events for different Higgs masses

M_H(GeV)	115	135	155	175
Charge flips	2.35±0.90	1.40±0.53	1.12±0.43	0.89±0.31
QCD	2.35±1.04	2.04±0.83	1.64±0.69	1.16±0.46
WZ	3.40±0.28	1.87±0.15	1.51±0.12	1.26±0.10
ZZ	0.34±0.03	0.21±0.02	0.17±0.01	0.15±0.01
Total	8.44±1.37	5.52±0.99	4.45±0.82	3.46±0.57
Signal	0.037±0.004	0.100±0.010	0.143±0.015	0.110±0.011
Data	9	6	6	6

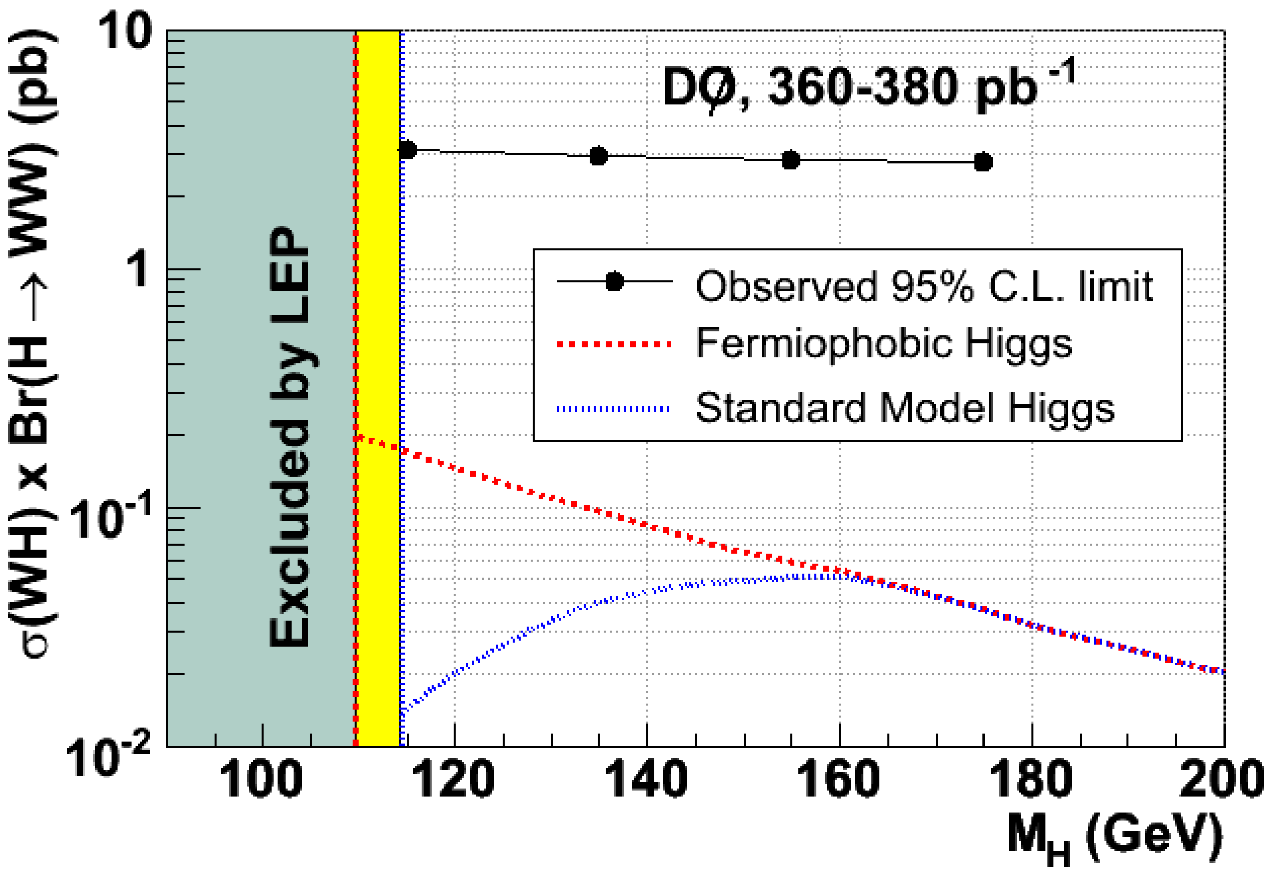
All three channels are combined and TLD cut is optimized for best expected limit for each mass and channel individually.

Observed number of events is consistent with SM background prediction, therefore cross-section limit can be established

Results: Expected and observed limits at the 95% C.L. for the associated Higgs boson production

M_H(GeV)	115	135	155	175
Expected limit (pb)	3.3	2.8	2.3	2.0
Observed limit (pb)	3.2	2.9	2.9	2.8

Expected and observed limits at the 95% C.L. for the associated Higgs boson production



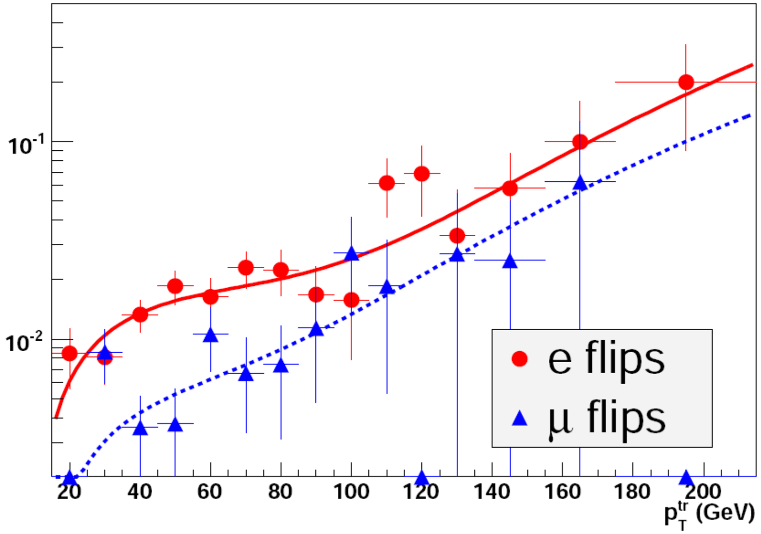
Conclusion:

- A search, using 360-380 pb has been performed for the process WH$\rightarrow$WWW$\rightarrow l^{\pm}\nu l'^{\pm}\nu' + X$ in the ee,eμ and $\mu\mu$ channels.
- Data events are in agreement with SM prediction.
- Upper limit on σ(WH)xBr(H$\rightarrow$WW*) was set
- Results of the search are being combined with other Higgs channels.

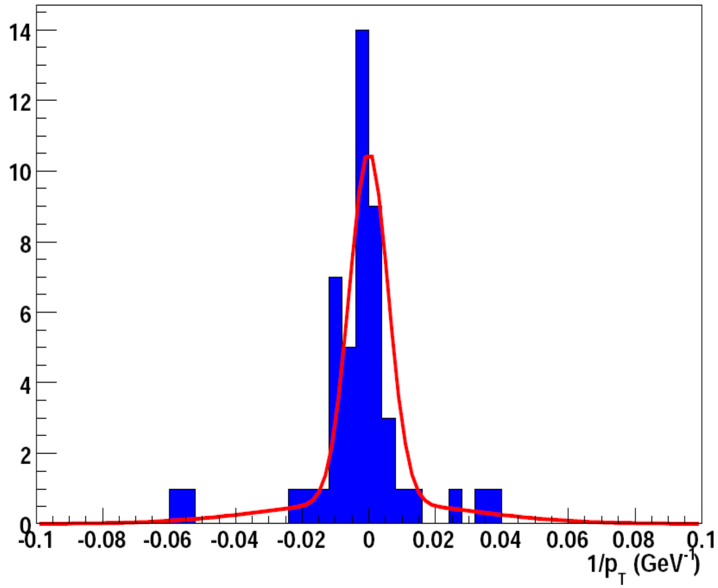
The End

Charge flip probability and $1/p_T$

Charge flips in MC



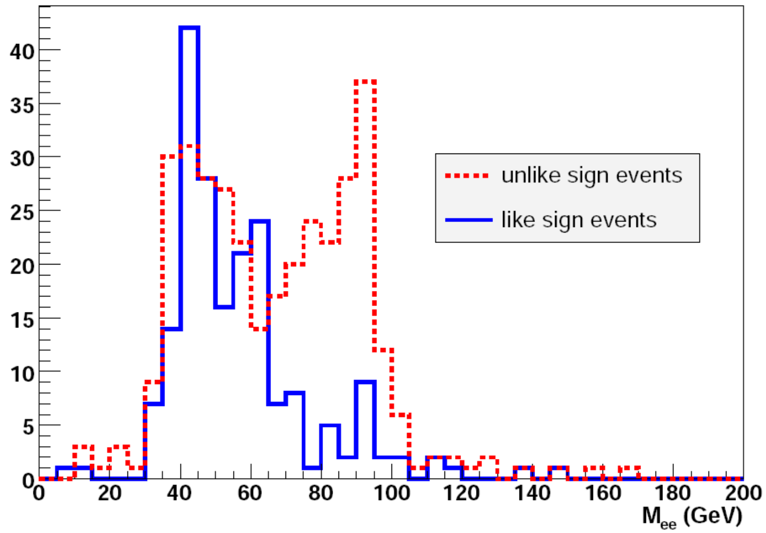
$1/p_T$ for muon flips in MC



Muons with misreconstructed charge acquire random q/p_T, Shape of q/p_T is used to make invariant mass plot

QCD invariant mass distribution

ee channel



μμ channel